US005776136A

# United States Patent [19]

## Sahay et al.

[54]  **METHOD AND SYSTEM FOR FINISH CUTTING BONE CAVITIES**

[75]  Inventors: **Alind Sahay**, Sacramento; **Zhenghao Yeh**, Stevenson Ranch, both of Calif.

[73]  Assignee: **Integrated Surgical Systems, Inc.,** Sacramento, Calif.

[56]  **References Cited**

### U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 5,086,401 | 2/1992 | Glassman et al. | 395/94 |
| 5,198,877 | 3/1993 | Schulz | 356/375 |
| 5,383,454 | 1/1995 | Bucholz | 128/653.1 |
| 5,468,243 | 11/1995 | Halpern | 606/80 |
| 5,534,005 | 7/1996 | Tokish, Jr. et al. | 606/80 |

### FOREIGN PATENT DOCUMENTS

WO 91/07726  5/1991  WIPO ............................ G06F 15/72

### OTHER PUBLICATIONS

Ault, T. et al., "Frameless Patient Registration Using Ultrasonic Imaging," The Robotics Institute, School of Computer Science, Pittsburgh, Pennsylvania pp. 74–81.

Cain, P. et al., "Safety Considerations in a Surgical Robot," Integrated Surgical Systems, Inc., Sacramento, California, Paper #93–035, pp. 291–294 (1993).

Champleboux, G. et al. "An Optical Conformer for Radiotherapy Treatment Planning," *TIMC–IMAG,* Faculte de Medecine de Grenoble, La Tronche, France, pp. 69–73.

Grimson, W.E.L. et al. "Automated Registration for Enhanced Reality Visualization in Surgery," pp. 82–89.

Kazanzides, P. et al. "Architecture of a Surgical Robot," IEEE Conference on Systems, Man, and Cybernetics, Chicago, Illinois, pp. 1624–1629 (1992).

Kazanzides, P. et al. "Force Sensing and Control for a Surgical Robot," IEEE Conference on Robotics and Automation, Nice, France, pp. 612–617 (May, 1992).

Kazanzides, P. et al. "Surgical and Industrial Robots: Comparison and Case Study," Integrated Surgical Systems, Inc., Sacramento, California, pp. Oct. 19 –Oct. 26 (circa 1994).

Lavalle, S. et al. "Computer Assisted Spine Surgery: A Technique for Accurate Transpedicular Screw Fixation Using CT Data and a 3–D Optical Localizer," *TIMC* Faculte de Medecine de Grenoble, La Tronche, France, pp. 315–322 (1995).

Lea, J.T. et al. "Registration and Immobilization for Robot–Assisted Orthopaedic Surgery," Department of Mechanical Engineering, Northwestern University, Evanston, Illinois, pp. 63–68.

Lombardi, Adolph V., Jr. "Cement Removal in Revision Total Hip Arthroplasty," *Seminars in Arthroplasty* 3(4) :264–272 (Oct., 1992).

Mittelstadt, B. et al. "Development of a Surgical Robot for Cementless Total Hip Replacement," *Robotics* 3:553–560 (1993).

Mittelstadt, B. et al. "Robotic Surgery: Achieving Predictable Results in an Unpredictable Environment," Integrated Surgical Systems, Inc., Sacramento, California, pp. 367–372 (1993).

[57]  **ABSTRACT**

Methods and systems for finish cutting of bone cavities rely on making a plurality of axial finish cuts along the cavity wall. Finish cuts are made using a rotary cutter, and a sufficient number of cuts are made to limit the radial height of cusps between adjacent cuts resulting from the arcuate shape of the cut profile. Cutting time is reduced by selectively terminating the axial lengths of the finish cuts in a manner which does not result in unacceptably high radial cusp heights between adjacent cuts.

**9 Claims, 7 Drawing Sheets**